THE REINTERVIEW EVALUATION OF THE 1990 POST ENUMERATION SURVEY

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1. INTRODUCTION

In the spring of 1991, the United States Census Bureau conducted a one-time large scale reinterview survey to estimate components of error in the coverage estimates derived from the 1990 Post Enumeration Survey (PES). The reinterview was called the Evaluation Follow-up (EFU). The EFU was part of the Census Bureau's comprehensive program to evaluate the undercount estimates from the PES (Bateman, et al, 1991). Since bias estimation was the goal, the priority for the EFU was data quality. Even though the reinterview occurred 10 months after the first contact with the respondents, the EFU obtained a 98.5% response rate. This paper describes the methodology for the design and the implementation of the reinterview survey. Estimates of bias due to error components measured in the survey are also reported.

2. METHODOLOGICAL BACKGROUND

The Census Bureau uses the data from the PES to evaluate coverage error in the census. The PES methodology is based on dual system estimation (DSE), the two systems being the census and the PES, an independent sample-based count of the population (Marks et al, 1974; Wolter, 1986). The PES itself is composed of two overlapping samples, the P sample and the E sample, the former being a sample of the population independent of the population, and the latter, a sample of the census enumerations. The E sample measures erroneous enumerations in the census and the P sample measures census omissions. A two-way match of the P sample to the Census, and the P sample to the E sample is performed. The PES information for nonmovers is matched with the census. All persons found in both the P sample and the E sample are classified as matched and correctly enumerated. Persons interviewed in the P sample and not matched to the Census are considered missed in the Census. Persons in the E sample who are not matched to the P sample are reinterviewed to determine if they were correctly or erroneously enumerated in the Census. Together the samples are used to produce an estimate of census coverage error (Hogan, 1991).

The DSE is subject to various sources of sampling and nonsampling errors. Models of total error and the components of error have been developed (Mulry and Spencer, 1988). These error components combine in the dual system estimation model to cause differences from population counts that would be obtained under an error free program (Mulry, 1991; Mulry and Spencer, 1988; 1991; 1992).

The goal of the reinterview was to provide empirical data for the estimation of the error components. Specifically, the survey was to provide data that would make possible an evaluation of bias in the PES estimates of undercount attributable to 1) quality of Census Day address and other P sample data collection errors such as fabrication and 2) error in estimation of erroneous enumerations. For a discussion of other error components and the total error model, reference can be made to Mulry and Spencer (1991).

3. SURVEY INSTRUMENTS

Approximately 11,000 households nationwide were revisited in the EFU. Two different questionnaires were used: the PES Follow-up questionnaire and the Revisit questionnaire.[1] The PES Follow-up questionnaire was used during the PES. The Revisit questionnaire was designed especially for the EFU operation. The design of both questionnaires addresses one of the primary goals of the reinterview which was to identify movers who did not report themselves as movers in the PES interview. The wrong Census Day address would lead the matching operation to search in the wrong area for the person's census enumeration, thereby possibly causing a false nonmatch to the census.

3.1 The PES Follow-up Questionnaire

The PES Follow-up questionnaire was used to visit P sample cases that were not part of the PES follow-up operation. This included a control sample of cases that were previously matched. Approximately, 2,500 households were administered this questionnaire.

The original PES interview questionnaire solicited information about the people living at the address at the time of the PES interview and their Census Day address. If the person(s) had lived at the address for less than a year, the interviewer asked for the April 1, 1990 address. To ensure that there were no other April 1 addresses where a person(s) might have lived, a list of alternate addresses was asked. This list of prompts included staying any part of March or April,

1990 at a college or university, with another relative, at a second home, on a military base or ship, or somewhere else.

In the Follow-up interview, the Census Day address was verified for person(s) in the P sample who did not match to the Census. For some respondents, questions were asked about the specific location of an address in order to resolve problems that had arisen when the address was geocoded to a census block.

3.2 The Revisit Questionnaire

The Revisit questionnaire was administered to both P sample and E sample cases in the EFU. The Revisit questionnaire was primarily intended to collect data to study address misreporting and the error in the number of people matching a census enumeration due to address misreporting. The sample cases that were administered this questionnaire, were both whole household nonmatches and households where only some of the persons matched (using the PES After-Follow-up match codes). Approximately 8,200 households were administered the Revisit questionnaire.

The questionnaire was more probing than the PES Follow-up questionnaire. The respondents were asked to reconcile information about person(s) listed in the PES, but not in the Census (P sample), or in the Census, but not in the PES (E sample).

In the P sample, the respondent was asked:

"In July, we conducted a Post Enumeration Survey to assess the accuracy of the census. When we interviewed your household, we listed _____ more person(s) in this household than we listed in the census we took in April. Our April records do not show (*Read names(s)*). I am trying to find out why we might have missed (this/these) person(s). Please take a look at this card (*Show flashcard*). Would any of these be likely explanations for missing (this/these) person(s)?"

The respondents were asked to state whether an alternate location could be a reason for missing the person(s). The flashcard listed possible alternate locations to help guide the respondent. This list corresponded to the one provided on the PES Interview form (college or university, with another relative, at a second home, on a military base or ship, or somewhere else). The respondents were then asked to provide the alternate address(es) and to indicate when the person(s) lived at the address(es). The interviewer was trained to make a note of any information that would help solve the match status.

In the E sample, the respondent was asked a similar question to reconcile the discrepancy. The reference time was the Post Enumeration Survey (July) rather than the Census (April).

During the EFU preparation, a staff of matching experts in each processing office wrote additional questions on the questionnaires to help collect information that would resolve the match status of specific persons. If a duplicate was suspected an example of a question would be: "Is Robert Smith (age 13) the same as Robert K. Smith (age 3)?" For any household with more than one type of questionnaire, the interviewers were instructed to do a combined interview.

4. DATA COLLECTION

4.1 Sample Design

The PES was a sample of about 170,000 housing units in approximately 5,400 sample block clusters. A block cluster is either one block or a collection of several small blocks. For the purpose of the EFU, a stratified systematic subsample of 920 block clusters was created. Within each of these block clusters, the EFU flagged cases that were to be sent to the field for interview.

The data collection for the EFU took place in February, 1991. Personal visits were made to approximately 11,000 households nationwide by Census Bureau Current Survey interviewers or other experienced Census Bureau employees. The interviewers were restricted to work in areas different from the areas where they worked during the PES. This was done to ensure interviewer independence in data collection between the PES and the evaluation. The data were collected from thirteen regional field offices and census centers.

4.2 Data Quality

A number of issues were of concern regarding the field operation and the quality of the data. One of the concerns was to find knowledgeable respondents and to obtain a low nonresponse rate. Another concern was to complete the collection in a short period of time period without compromising the quality of the data.

4.2.1 Response rate

The households in the sample had been contacted several times by the Census Bureau in the months preceding the EFU. Their willingness to respond was therefore uncertain. However, when reviewing the outcome of the field operation, it is evident that the many years of interviewing experience accumulated by most of these enumerators were instrumental in once again getting assess to the public. Refusals did not have an impact on the operation.

In the P sample EFU, data were collected for a total of 14,911 persons. Overall, the response rate was 98.7%. Ninety percent of the interviews were completed with a household member. About 8.5%

were completed with a nonhousehold member, .2% were classified as interviews refused, and 1.3% as noninterviews.

In the E sample EFU, data were collected for a total of 11,992 persons. Overall, the response rate was 98.5%. Eighty-six percent of the interviews were completed with a household member, 12.5% by a nonhousehold member, .2% were classified as interview refused, and 1.3 % as noninterviews.

Many steps were taken to ensure the low nonresponse rate. For example, in a special meeting with the managers in the field offices, we stressed that it was crucial to limit the nonresponse rate. The message from Headquarters to the field was simple. There would be no time for follow-up visits at a later time to nonresponse households. Therefore, since every respondent was important, concerns for monetary cost were not to prevent an interview from taking place. For example, one manager was told he could charter a boat to reach a case in a remote area. If respondents had moved, telephone interviews were acceptable. Managers collaborated when isolated cases were close to the borders of their regions. Sometimes such cases were more accessible to an interviewer in another regional office.

4.2.2 Time constraints

Personnel from Headquarters monitored the field operations daily and were able to take immediate actions if problems arose. In order to meet tight court ordered deadlines, and still allow as much time as possible for data collection, special allowances were made in the procedures. For example, should the situation have occurred, to reduce time delays, we were prepared to deliver in person 'prepped' questionnaires from the processing offices to the field offices, even if it meant sending one person by commercial plane on a Saturday or Sunday. Similarly, the interviewers were instructed to return completed questionnaires by air mail or overnight delivery.

4.2.3 Proxy respondents

Given the time lag since the first contact with the respondents, another concern was the quality of the data, especially of the data obtained from proxy respondents. This concern appears to have been unwarranted (Table 4.2.3.1).

Table 4.2.3.1 Percent Distribution of Type of Respondent by EFU Match Status

Respondent in EFU	Match status			
	Re-solved	Unre-solved	Total	(N)
Househ. Memb.	94.5%	5.5%	100.0%	(13,443)
Proxy	84.5%	15.5%	100.0%	(1,266)

Though the percentage of cases with unresolved status was higher where the respondent was a proxy rather than a household member, almost 85% of the data collected from proxies resulted in a match status of resolved. Ninety-five percent of the data collected from household members was classified as resolved.

The proxy cases were not concentrated in any geographical region. A difference was observed in some of the central cities, but it was not statistically significant. Nineteen percent of the proxy cases, compared to 12 percent of the household member cases, fell in the evaluation stratum representing minorities in central cities in the Northeast. The same pattern was found among minorities in central cities in the Midwest (16% versus 10%). In all other geographical areas, the distributions of proxy and non-proxy cases were the same.

4.3 Monetary budget

The topic 'monetary budget' is closely linked to data quality. The EFU budget allowed for special staffing and implementation costs. The budget allowed us to get across to the support staff the high priority and importance of the reinterview. Many obstacles were eliminated before they could affect data quality or slow down the process. It is unlikely, a reinterview of this size could be completed in such a small amount of time with a high quality of results without an adequate budget. The cost for the field operation was close to 0.5 million dollars. This translates into $45 per interview. The cost of clerical processing for these cases was 0.8 million dollars.

Once the data were collected, the questionnaires were sent to the processing offices for the matching operation. This process is discussed next.

5. PROCESSING OFFICE OPERATIONS

5.1 Matching

The questionnaires went through a matching operation that drew on the experience gained from the PES. The basic matching rules and guidelines for the EFU matching operation did not change from PES. The matching classified persons as included in the Census only if they were counted at the address where they should have been counted, according to the information they provided. If a person reported living

at a certain address, then the matching classified this person as correctly enumerated if he or she was counted anywhere in the census block itself or in an adjacent block. The match codes assigned to the EFU sample cases were the PES match codes.

Though alike, there were some differences between the two operations. In the PES, all questionnaires went through computer matching. The EFU did not have a computer matching stage.

In the EFU, a team of matching experts was formed to review the completed EFU questionnaires and to assign match codes to the cases selected for the EFU sample. This team of matching experts consisted of Matching Technicians (usually referred to as the Techs) and Matching Review Specialists (also known as the MRS). The MRS were the highest level matchers from the PES. The PES used the higher level matchers to review only problem clusters and resolve differences.

The matching experts were instructed to use their judgement and to utilize all notes on the EFU questionnaires. Here, the operation benefited from the high quality of the field data. Enumerators assigned to the EFU were experienced and very thorough in their interviewing. Frequently, the notes on the questionnaires provided sufficient information to resolve a match status.

In addition to the team of matching experts, a team leader was placed in each of the seven processing offices. This team leader was a member of the Census Bureau's permanent matching staff in the Jeffersonville Processing Office.

5.2 Consistency Checks

During the PES matching operation consistency checks were performed to ensure that only data of high quality were used in the evaluation. As in matching after the PES Follow-up, new information collected during the EFU was compared with information collected during the PES Follow-up and during the initial PES interview. As previously stated, the field interviewers had been trained and instructed to provide extensive documentation on the questionnaires for any information they collected. These elaborate notes were valuable for the matchers in determining what was happening in the households visited. It proved very helpful for the team leaders in making decisions about individual cases.

The rule was to accept the PES match codes if new information did not emerge from the EFU interview. In other words, it was not within the scope of the EFU to change match codes inappropriately assigned during the PES matching operation. Such matching errors were evaluated in a study designed especially for this purpose (Davis et al, 1991). Thus, if the information collected in the EFU interview was the same as that collected during the PES initial interview and follow-up, there were no inconsistencies and the PES match codes were retained. A new match code was assigned only if new, consistent and reliable information was collected.

If the new information was inconsistent with existing information and there was a strong conviction that it was less reliable than previous information, the EFU interview became 'not accepted'. As a rule of thumb, information provided by a household member would be deemed more reliable than information from a proxy respondent, everything else equal. Overall, 3.2% of the data collected from a household member were disregarded compared with 19.5% of the data from proxy respondents.

EFU data were not accepted for a total of 825 cases - 635 P sample cases (this number represents 4.2% of the total P sample workload) and 290 E sample cases (this number represents 2.4% of the total E sample workload).

When focusing on the cases that were rejected, it is seen that 11% were matched in the PES, 63% were nonmatch cases, 3% out of scope and 23% unresolved in the PES (Table 5.2).

Table 5.2.1 Percent Distribution of Rejected EFU Cases by PES Match Code

PES Match Code	Rejected
Match	11.0%
Nonmatch	63.0%
Out of Scope	3.0%
Unresolved	23.0%
Total	100.0%
(N)	(825)

When the EFU interview was disregarded, a notation was made of the reason for rejecting the data. We looked at the reasons given for rejecting new information about a case and categorized these reasons, based on a content analysis of the data. The main categories of reasons included response obtained from proxy respondents vs. household members and geocoding inconsistencies.

In order to learn as much as possible about the impact of the consistency check, we reviewed the rejected cases further. Our review focused on 1) differences across the processing offices and 2) the prevalence of the rejected cases by evaluation post-stratum.[2] The review did not reveal any significant differences across processing offices or strata in rejecting the data. Furthermore, the review did not find evidence that the EFU matching clerks were more likely to reject data that would result in a nonmatch rather than a match.

6. SCHEDULE

The time budget for the reinterview survey was of great concern because of the deadline for results imposed by an out-of-court settlement in a lawsuit. The decision about adjustment of the 1990 Decennial Census was scheduled to be announced by the Department of Commerce on or before July 15, 1991. As it can be seen from the schedule of selected activities, there was not much time to spare (Table 6.1).

Table 6.1. Schedule Of Selected Activities

Activity	Begin	End
1. Instrument	02/01/90	12/01/90
2. Sampling	11/21/90	01/23/91
3. Interviewing	02/01/91	03/01/91
4. Matching	03/01/91	04/01/91
5. Keying data	03/15/91	04/05/91
6. Analyses	03/31/91	05/15/91
7. Assess accuracy	05/15/91	07/15/91

Availability of the PES data for sample selection dictated the start of the EFU operation. Delays in census operations caused delays that had to be absorbed in the PES operations and in the EFU.

The intensity of the survey required the total full-time commitment of staff. Consequently, the Coverage Studies and Evaluation Staff was formed in the spring of 1990 to coordinate and oversee the implementation of the survey and to analyze the data.

7. RESULTS

As stated previously, a number of PES evaluation projects, including the total error model, used the data gathered in the EFU. The results regarding erroneous enumerations in the Census, address misreporting and other P sample errors, and fabrication of data are presented in this paper. It should be noted that the results are the evaluation of the PES (July 15, 1991) work. Evaluation results of work produced past that date are not included.

7.1 Erroneous Enumerations

Briefly, erroneous enumerations are those caused by, for example, geocoding errors (people enumerated at the wrong address). An address is considered correct if it is located within the PES search area, the search area being the block for the address and the ring (in TAR areas) or two rings (in other areas) of adjacent blocks. Other types of erroneous enumerations are duplicate enumerations, fictitious enumerations, people who died before Census Day, and people who were born after Census Day.

The concern of the evaluation is for measuring such census errors. Since the DSE requires estimating the number of distinct people captured in the census, a correction is made for erroneous enumerations in the estimate of total population.

Overall, weighted to the national level, almost 93% of the cases coded as correct enumerations in the production PES retained this match code after the EFU. In comparison, only 65% of the cases coded as erroneous enumerations in the production retained this match code after the EFU. More than 28% of the erroneous enumerations became correct enumerations. Finally, 90% of the unresolved cases became correct enumerations. It should be noted that high coefficients of variation were associated with these results.

7.2 Address Misreporting

Dual system estimation assumes that P sample respondents can be linked, or matched, correctly to the census at their Census Day address. Census Day was on April 1, 1990. The PES was conducted in July and August, 1991. Thus, some of the respondents had moved between the time the census was conducted and the PES was in the field collecting data. In spite of extensive probes on the PES Interview questionnaire, respondents may have failed to report that they moved in the interim. This type of error may cause the matching operation to search the Census in an area other than where the respondent should have been enumerated and to assign a nonmatch status to respondents that actually were correctly enumerated in the Census. Inappropriate assignment of the status of nonmatch may cause the estimate of the number of people missed by the census to be biased upward. The EFU provided an opportunity to assess this type of response error.

It is the finding that 334 respondents changed from a nonmover in PES to a mover in EFU. This represents 2.2% of the P sample. Weighted to the PES unweighted totals, there were 2,416 new movers (s.e.= 510). This represents .69% of the P sample. Similarly, weighted to the U.S., there were 1,409,921 new movers (s.e. = 305,489). This represents, .66% of the total population.

The match statuses at the new address were as follows: Among the new movers, who previously matched at their sample address, 62% matched at their new address. On the other hand, among the cases that previously matched, 37% became unresolved. Among the nonmatches, 40% became matches, 12% remained nonmatches, 6% became out of scope, and 41% unresolved. Among the cases that were unresolved in the PES, 48% became matches, 5% out of scope, and 47% remained unresolved.

As seen in Table 7.1.2 which shows the data weighted to the national level, the coefficients of

Table 7.2.1 Changed From Nonmover in PES to Mover in EFU - Estimates and Coefficients of Variation. Weighted to the Total Population

Results of Evaluation	Results of Production			Total
	Match	Nonmatch	Unresolved	
Match	358,252 (68.04%)	301,649 (21.18%)	35,234 (56.01%)	695,134 (36.37%)
Nonmatch	0 (0.00%)	94,403 (37.86%)	0 (0.00%)	94,403 (37.86%)
Out of Scope	3,632 (68.03%)	48,226 (32.02%)	3,315 (91.17%)	55,173 (29.63%)
Unresolved	218,429 (59.83%)	312,530 (20.91%)	34,252 (52.94%)	565,211 (26.08%)
Total	580,313 (47.64%)	756,807 (16.77%)	72,800 (41.03%)	1,409,921 (21.67%)

variation on these estimates are high. Also, it should be noted that the matching rules did not allow matched or unresolved cases to be converted to nonmatches.[3]

7.3 Fabrication in the P sample

Quality assurance in the PES was designed to detect and correct fabrication in the data. In spite of such measures, fabricated cases might remain in the data. The creation of fictitious individuals may decrease the PES match rate, causing the estimate of coverage error to be too large. The EFU produced an estimate of the undetected number of people in the P sample.

It was the finding that 13 cases, not previously identified in the PES as fictitious, received the match code of fictitious in the EFU matching operation. Expressed differently, among the cases sent to the P sample Follow-up that fell in the evaluation sample, .09% were not coded as fictitious in the PES. Weighted to the PES unweighted totals, these 13 cases represent 96 cases with a standard error of 57, or .03% of the total sample. Weighted to the national total, the 13 cases represents 64,667 cases, or .03% of the total estimated population. The standard error of this estimate is 39,419.

8. EFFECT OF ERRORS

The implications of the results on the DSE estimate of undercount were the primary concern in the July 15, 1991 adjustment decision. The method used to obtain the estimated bias is presented next.

As previously stated, the Census Bureau has adopted the DSE method to estimate the number of distinct people enumerated in the census. To estimate this number, we use $\hat{N}_{CE}$ obtained as follows. Let I_C denote the number of persons imputed into the

original enumeration, let I_E denote the number of persons counted in the census for whom names are not available, let $\tilde{I}_E$ denote the weighted number of census enumerations (from the E sample) with insufficient information for matching, and let $\hat{E}_E$ denote the weighted number of erroneous enumerations that were included in the E sample. If all those quantities were known, the estimated size of the population that could possibly be matched would be $\tilde{N}_{CE} = \hat{N}_C - I_C - \tilde{I}_E - \hat{E}_E$. As $\hat{E}_E$ and $\tilde{I}_E$ are estimated, we substitute their estimates $\hat{I}_E$ and $\hat{E}_E$, and obtain $\hat{N}_{CE} = \hat{N}_C - I_C - \hat{I}_E - \hat{E}_E$.

Next, let N_{CP} denote the weighted number of P sample selections who were enumerated in the census, and let $\hat{N}_{CP}$, the weighted number of matches, be an estimate of that quantity. $\hat{N}_P$ is the weighted estimate of the total population from the P sample. We estimate N by

$$\hat{N} = \hat{N}_P \hat{N}_{CE} / \hat{N}_{CP} \qquad (1)$$

The DSE is used to estimate the percent net undercount, or the net undercount rate, in the original enumeration,

$$\hat{U} = 100(\hat{N} - \hat{N}_C) / \hat{N} \qquad (2)$$

The bias in the net undercount rate, $\hat{B}(\hat{U})$ is estimated by the difference between $\hat{U}$ and the mean of the simulated distribution of the undercount rate. We also calculated the standard deviation of the estimated bias.

The individual effect of the errors on bias, standard deviation and root mean square error of the undercount rate were computed for the nation. The results for the

errors estimated from the EFU data are reported in Table 8.1 below. For each component, assume that all other error components are zero. The undercount rate, $\hat{U}$, was estimated to 2.11 percent.

Table 8.1 Individual Effect of Errors on Bias, Standard Deviation and Root Mean Square Error of the Undercount Rate for the U.S.

Error Component	$\hat{B}(\hat{U})$	Std. Dev.	(MSE)$^{1/2}$
P-sample Collection	0.33*	0.11	0.33
E-sample Collection	-0.17	0.11	0.20

* Significant at the 0.05 level of probability

Overall, the results indicate that the bias in the undercount estimate introduced by the error components estimated from the EFU are small.[4] Though the bias for P-sample collection errors is statistically significant, it amounts to only a third of one percentage point.

9. CONCLUSION

The design, implementation, and analyses of the EFU have been documented in this paper. The EFU was one of the largest one-time reinterview surveys ever undertaken by the Bureau of the Census. The results were used to evaluate PES data quality. Specifically, the reinterview provided empirical data to evaluate components of response error in the PES such as address misreporting, fabrication of P-sample cases, and erroneous enumerations in the E sample. The PES produced estimates of coverage error in the 1990 Census. These estimates were available for the Department of Commerce decision regarding adjustment of the 1990 Census.

Based on the information collected in the EFU, the PES data were of high quality. The impact of fabrications and erroneous enumerations on the PES estimates of undercount were negligible. The bias resulting from P-sample collection errors was statistically significant. However, it amounted to only a third of one percentage point.

The EFU had a number of obstacles and problems to overcome. One of these obstacles was the time constraint. The completion date for the analysis results was predetermined. Therefore, the overriding concern at every stage of the survey was to meet the deadline. Fortunately, though on a much smaller scale, the EFU design, including specifications for field and matching operations, had been tested in the 1988 Dress Rehearsal PES. Thus, previous experience could be drawn upon in the implementation. Without such experience, a survey of this size could not have been implemented in the allotted time.

Respondent cooperation was another concern. Given the frequency of contacts in the 1990 Census and then the PES, it was uncertain how the interviewers would be received by the public. We obtained a response rate of 98.5%. There is no doubt that refusals were kept to a minimum due to the training and experience of the interviewers. Without such staffing resources, a high interview completion rate cannot be expected.

Finally, high data quality was a concern. The quality of the reinterview data was evaluated in the EFU matching operation. In spite of the time lag between the original interview and the reinterview, only a fraction of the data was judged unreliable. Again, the training and background of the interviewers were a factor.

Overall, the reinterview yielded important information about response error in the original survey. Future coverage evaluation programs can benefit from the experience gained in the 1991 Evaluation Follow-up.

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FOOTNOTES

1. An evaluation of missing data were also conducted based on the EFU. For this purpose, the original PES interview questionnaire was utilized.

2. Thirteen evaluation post-strata were created for the evaluation.

3. For further discussion of these results see West et al, 1991.

4. A full description of how the results from the evaluations of the PES estimates were combined to yield an assessment of their collective effect on the dual system estimator is given in Mulry, 1991.

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